BGSU

BOWLING GREEN STATE UNIVERSITY

Environmental Health and Safety

CHEMICAL

HYGIENE

PLAN

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INTRODUCTION

Policy Statement

"It is Bowling Green State University's policy to comply with the occupational safety and health standards of the Ohio Public Employees Risk Reduction Act and all applicable Federal, State, and Local rules, regulations, and directives."

Approved October 7, 1994
Board of Trustees

Forward

In 1970, the United States Congress established the right of workers to "safe and healthful working conditions" through the Occupational Safety and Health Act. This act created the Occupational Safety and Health Administration (OSHA). In July, 1994 the State of Ohio adopted and incorporated by reference many of the Federal OSHA standards through the Public Employee Risk Reduction Act, Ohio Revised Code 4167.07. This act and its subsequent rules (Ohio Administrative Code 4167-3-01) required Bowling Green State University and other state institutions to comply with all applicable OSHA standards.

The Laboratory Safety / Chemical Hygiene Plan has been established by Bowling Green State University to comply with Ohio's Public Employee Risk Reduction Act, the OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard 29 CFR 1910.1450, and the OSHA Personal Protective Equipment Standards of 29 CFR 1910 subpart I.

Certain safety and health hazards exist in the University laboratories and must be addressed. Everyone involved in any aspect of lab functioning has a legal and moral responsibility to act in such a way to reduce risks from potential hazards in the laboratory.

The Plan is designed to accommodate the wide variety of laboratory activities on campus and to minimize unnecessary burdens placed on departments or researchers. Recognizing the vast number of chemicals and procedures that may be used on the University campus, the Plan establishes general safe operating procedures and provides guidelines for the development of specific laboratory procedures. The responsibility for ensuring safety in the laboratory ultimately rests with the individual in charge of that laboratory.

Ensuring safety through health hazard reduction should be viewed as a good prudent professional practice, not as merely an additional administrative requirement. Risks can never be reduced to zero, but by practicing simple and safe laboratory procedures, they can be reduced dramatically. The intent of the Plan is to help laboratories reach a level of safety and risk minimization that is entitled to all workers.

Objective

The objective of the Plan is to provide safe and healthful working conditions in the laboratories of Bowling Green State University through education, awareness, and protective laboratory practices and equipment. The Plan is a base-line for safety procedures. It also provides guidance for developing safe practices for specific hazardous situations. This Plan should also be used in conjunction with all other applicable policies and procedures relating to the work performed in the laboratory.

Applicability

The Plan applies to all laboratories that can be defined as workplaces in which relatively small quantities of substances are used on a non-production basis. Where the Plan applies, it shall supersede for laboratories the requirements of BGSU's Hazard Communication Program.

Specifically, the Plan applies to "laboratory use of hazardous chemicals." Rooms are covered by the Plan if they meet the following four requirements:

- Chemical manipulations are carried out on a "laboratory scale" (means work with substances in which the containers used for reactions, transfers, and other handling are designed to be easily used and manipulated by one person);
- Multiple chemical procedures or chemicals are used;
- The processes involved are not production processes, nor in any way simulate a production process; and
- Accepted lab procedures, practices and equipment are used to minimize chemical exposure.

Responsible Parties

Department Chairs shall see that their department observes the general provisions of the Plan and that additional measures are developed for specific laboratory safety procedures when needed. Chairs are also responsible for identifying the individual(s) who are responsible for the adherence of laboratory safety procedures in the instructional laboratories. The individual(s) could be the instructor of each laboratory or one individual could be appointed for all laboratories. Responsible individuals shall be referenced as Principal Investigators.

Principal Investigators are responsible for everything that occurs in their laboratories including the adherence to safety procedures. This includes good laboratory practice and adherence to the general provisions of the Plan. They are also responsible for developing specific safety measures as needed for their research program and contacting the Department of Environmental Health and Safety for advice when needed.

Laboratory Employees are responsible for following all safety procedures, and for reporting any unsafe conditions or accidents to the Principal Investigator.

Chemical Hygiene Officer is responsible for providing technical guidance in the development and administration of the Plan and in coordinating its implementation. The Chemical Hygiene Officer is Bowling Green State University's Industrial Hygienist, an employee of the Department of Environmental Health and Safety.

Department of Environmental Health and Safety is responsible for disseminating the requirements of the Plan and for supporting the departments and investigators in achieving laboratory safety. Through the Chemical Hygiene Officer, the Department of Environmental Health and Safety will coordinate activities related to the Plan.

Definitions

This is a select list of definitions used in the Plan. An additional list is included in the text of the Standard, which is attached in Appendix C.

ACGIH is the American Conference of Governmental Industrial Hygienists.

Acute Toxicity means having high probability of causing adverse health effects from a short term exposure to a small amount of a substance.

Carcinogen means any substance, which meets one of the following criteria:
(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP.

Laboratory Hood means a device located in a laboratory, enclosed on five sides with a movable sash or fixed partial enclosure on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

LC_{50} means the airborne concentration of a given substance that when inhaled over a period of time will kill 50% of the animals under test.

LD_{50} means the amount of a chemical, per unit of body weight, that will cause death in 50% of test animals.

Material Safety Data Sheet (MSDS) is a summary of the important health, safety, and toxicological information on a chemical or mixture.

OSHA is the Occupational Safety and Health Administration.

Permissible Exposure Limit (PEL) is an exposure limit that is published and enforced by OSHA as a legal standard.

Reproductive Toxin means chemicals, which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

> **(A)** After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);
>
> **(B)** After repeated skin application of less than 300 (mg/kg of body weight) per week; or
>
> **(C)** After oral dosages of less than 50 mg/kg of body weight per day.

Sharps are any objects that can penetrate the skin including, but not limited to, needles, scalpels, broken glass, and broken capillary tubes.

Threshold Limit Value (TLV) is an ACGIH determined concentration of a chemical that an employee can be exposed to for a given period of time. There are 8 hour TLVs, short term (15 minute) TLVs, and ceiling (maximum concentration) TLVs. TLVs are not legally enforceable, but represent good practice.

STANDARD LABORATORY PROCEDURES

By observing safe standard operating procedures the vast majority of laboratory hazards can be controlled and the effects of an accident reduced. The most important laboratory procedure that can be implemented is that of an attitude of safety, which applies to department chairs, principal investigators and laboratory workers. A constant awareness of the potential for hazardous conditions to exist will result in an acceptable level of preparedness and prompt correct response in case of an accident.

There are several standard laboratory procedures that all laboratories must follow. These standard laboratory procedures reduce the risk from hazards present in the laboratory. A list of standard laboratory procedures is included in this section.

STANDARD LABORATORY PROCEDURES

Behavior

- Behave professionally at all times.
- Do not engage in horseplay or jokes.

Personal Attire

- Wear closed toe shoes in laboratories. Sandals are not permitted.
- Do not wear porous or absorbent watch straps in laboratories.
- Avoid excessively loose or baggy attire, which may include loose sleeves, long neckties, long unrestrained hair, and hanging jewelry.

Personal Hygiene

- Do not apply cosmetics in lab.
- Do not eat or drink in lab.
- Do not store food in lab refrigerators.
- Do not drink from eye wash station.
- Do not use lab glassware for holding food or drink.
- Avoid skin contact with chemicals.
- Wash hands often while in lab and thoroughly before leaving.

Chemical Handling

- Never smell or taste chemicals.
- Always assume a chemical is hazardous.
- Do not use chipped or broken glassware.
- Place chemicals back from the edge of shelves, tables or benches.
- Keep work area clear and uncluttered.
- Do not pipette by mouth.
- Use only the amount needed.
- Waste chemicals will be handled in accordance with the University's Hazardous Waste Program.

Respiratory Protection

Use respiratory protection to control exposure to hazardous chemicals when other control measures (i.e. lab hoods or general ventilation) are insufficient to reduce chemical exposures below the acceptable level. Any use of respiratory protection equipment must comply with BGSU's Respiratory Protection Program including medical clearance for use, training, and fit testing.

Fire Protection

Know fire procedures including evacuation and location and use of portable fire extinguishers. Contact the Department of Environmental Health and Safety for fire extinguisher training.

Phones and Emergency Numbers

- Post numbers to call in case of an emergency, including the phone number of the Principal Investigator for the lab.
- Have the BGSU Emergency Procedures Poster located by the phone.

Chemical Storage

General Requirements

- Only authorized laboratory employees shall have access to chemicals.
- Segregate incompatible materials to prevent contact with one another. Appendix D contains acceptable chemical storage methods to segregate incompatible materials.
- Separate boxes containing chemicals. Do not stack them.
- Use only explosion-proof refrigerators to store liquids, which could produce explosive vapor concentrations.

Flammable Solid and Liquid Storage

The presence of flammable liquids in the laboratory presents a significant potential for fires and explosions in the laboratory. To minimize the potential for fires and explosions, flammable liquids must be stored as follows:

- No more then 38 liters of flammable liquid can be stored outside a flammable liquid cabinet. This is equivalent to about nine 4-liter bottles stored in the laboratory outside of a flammable cabinet.
- Flammable storage cabinets do not need to be ventilated for fire protection. However, they can be ventilated to control odors.

Refrigerated Flammable Liquid Storage

Using domestic refrigerators and freezers for storage of flammable material is prohibited. Flammable vapors can accumulate in domestic refrigerators and freezers. When flammable vapor accumulates to a specific level and a source of ignition is provided (a thermostat, light switch, etc.), a fire or explosion can result.

Flammable liquids may only be stored in refrigeration equipment that is *explosion proof, explosion safe, laboratory safe,* or designated for *flammable material storage*. These refrigeration units must be approved by Underwriters Laboratory as acceptable to store flammable liquids.

Gas Cylinders

- Secure compressed gas cylinders by chain or strap.
- When cylinders are not in use, the protective cap must be in place.
- Identify status of cylinders as “full”, “in-use”, and “empty”.

Peroxides and Peroxide Forming Chemicals

Peroxides can be highly reactive, powerful oxidizers, explosive, and highly flammable. There are generally three classes of chemicals that can form peroxides. The degree of explosion hazard depends on the the chemical, condition in which it is stored, and the conditions in which it is used.

Class A

Peroxidizable compounds which form explosive compounds without being concentrated.

Organic	Inorganic
Divinyl ether	Potassium metal
Divinyl actylene	Potassium Amide
Isopropyl ether	Sodium amide (sodamide)
Vinylidene	

Class B

Chemicals that present a peroxide hazard when they are concentrated via distillation or evaporation. Specific distillation and evaporation procedures must be performed.

Acetal	Dioxane (p-dioxane)
Cumene	Ethylene glycol dimethyl ether (glyme)
Cyclohexene	Furan
Cyclooctene	Methyl acetylene
Cyclopentene	Methyl cyclopentane
Diacetylene	Methyl-*i*-butyl ketone
Dicyclopentadiene	Tetrahydrofuran
Diethylene glycol dimethyle ether	Tetrahydronaphthalene
Diethyl ether	Vinyl ethers

Class C

Unsaturated materials that may polymerize violently and hazardously due to peroxide initiation.

Acrylic acid	Tetrafluoroethylene
Acrylonitrile	Vinyl acetate
Butadiene	Vinyl acetylene
Chlorobutadiene (Chloroprene)	Vinyl chloride
Chlorotrifluoroethylene	Vinyl pyridine
Methyl methacrylate	Vinylidene chloride
Styrene	

Testing for the presence of peroxides

Class A, B, and C must be tested for the presence of peroxides every three months. The chemical must be either redated as safe if no perioxides are present or disposed of through the University's Hazardous Waste Program.

Aqueous Peroxide Test Method

1. Add 1 to 3 mL of liquid to be tested in an equal volume of acetic acid.
2. Add a few drops of 5% aqueous potassium iodide solution.
3. Stir. Do not let the mixture touch your skin.

   The appearance of a yellow to brown color indicates the presence of peroxides.

   A yellow color indicates a low concentration of peroxides (less then 100 ppm). A brown color indicates a high concentration of peroxides (greater then 100 ppm).

   - Chemicals containing concentrations below 100 ppm may be treated to remove the peroxide contamination and stored for future use. Refer to the peroxide treatment section for details.

   - Chemicals containing more then 100 ppm of peroxides must be disposed of immediately through the University's Hazardous Waste Program. Contact 372-2171 for more information.

Peroxide Test Strips

1. Use a peroxide test strip to test for the presence of peroxides.

   - Chemicals containing concentrations below 100 ppm may be treated to remove the peroxide contamination and stored for future use. Refer to the peroxide treatment section for details.

   - Chemicals containing more then 100 ppm of peroxides must be disposed of immediately through the University's Hazardous Waste Program. Contact 372-2171 for more information.

Removal of Peroxides

This procedure must only be used for chemical solutions that contain less then 100 ppm of peroxides. Solutions greater then 100 ppm must be disposed of through the University's Hazardous Waste Program.

Activated Alumina Column Removal.

1. Prepare a column of activated alumina.
2. Pour the peroxide containing solution through the column.
   – Do not allow the column to dry out while in use
3. Re-test for the presence of peroxides. If peroxides are still present, pass it through the column untill you can not detect them.
4. When the alumnia column is no longer effective at removing the peroxides, wash the column with 5% aqueous ferrous sulfate and disgard the solution as hazardous waste.

Distillation and Evaporation Procedures

When using Class A, B, and C chemicals, this procedure must be used and integrated into protocols for these chemicals.

1. Test for the presence of peroxides.
   – if greater then 100 ppm, discard as hazardous waste
   – if less then 100 ppm, treat until you can not detect the presence of peroxides
2. Before distilling any Class C material, a suitable polymerization inhibitor must be added.
3. An explosion sheild must be used and placed between the evaporation or distillation process and the operator.
4. Safety goggles must be worn by the operator.
5. Evaporate or distill and leave at least 10% of the solution in the container. Most accidents occur when material is nearly a dry residue.

    - Use a boiling aid or magnetic stirrer before you use a nitrogen bleed to maintain ebullition.
    - In operations using higher boiling peroxidizable compounds under reduced pressure, an explosive mixture can result because the boiling temperature may be lower than the peroxide decomposition temperature. Contact the Environmental Health and Safety Department (372-2171) when preforming an operation of this type.

Contact Lenses

Do not wear contact lenses in laboratories.

Labeling

- Label hot surfaces.
- Do not remove or deface labels on incoming containers from manufacturers.
- Identify the chemical's name and health warnings associated with that chemical on labels for secondary containers.
- Label containers for immediate use, such as beakers and flasks, with the name of the chemical contents.
- Label all containers to avoid orphaned containers of unknown material.

Eye and Face Protection

- Only indirectly vented chemical splash goggles are to be worn for laboratory procedures requiring goggles.
- Safety glasses and goggles must conform to ANSI Z87.1.
- In the event of a chemical splash into the eye, flush with water for a minimum of 15 minutes and seek medical attention.
- Wash safety glasses, goggles, and face shields often with mild soap and water.
- Appendix B lists requirements for eye and face personal protective equipment, however, always consult the chemical's MSDS first.

Gloves and Skin Protection

- Wear appropriate gloves and other protective gear (laboratory coats and aprons) to avoid skin contact with chemicals.
- Inspect gloves for tears before use. Do not use damaged gloves.
- Follow the glove use recommendations established by the glove manufacturer.
- Appendix B lists requirements for glove and skin personal protective equipment, however, always consult the chemical's MSDS first.
- Gloves must be removed before leaving the laboratory to prevent contamination in non-laboratory areas.

Material Safety Data Sheets (MSDS)

MSDSs for all chemicals used in the laboratory shall be maintained in a readily accessible location for laboratory employees. They are located: _____.

Working alone

Avoid working alone. If it must be done, have a check-in system.

Alarms

Know what the appropriate actions are. Refer to BGSU's Emergency Procedures.

Hazardous Procedures

Inform co-workers when performing hazardous procedures.

Safety Inspections

- Review the results of monthly inspections, conducted by the laboratory's Principle Investigator or designee, and take corrective actions to correct deficiencies.
- Review the results of Environmental Health and Safety's annual safety evaluation and take corrective actions.
- Report all safety deficiencies to the Principal Investigator for the laboratory.

Electrical

Do not remove the ground plug on three-prong electrical plugs. Do not modify or use in two-prong outlets.

Sharps

Dispose of broken glass and other sharps in appropriate, labeled containers.

Laboratory Hoods

- When working in the hood, position the bottom of the sash to be in line with the 100 feet per minute arrow located on the front of the hood. The arrow is located where proper airflow velocities are achieved at the hood's face.
- Set up work inside the hood at least six (6) inches from the face opening. This will avoid turbulence at the sash edge and provide greater protection.
- Separate and elevate each instrument. Use blocks or racks to elevate equipment one to two inches off the hood work surface so that air can easily flow around all of them with no disruption.
- Keep only items needed for ongoing operation inside the hood. Excess materials in the hood disrupt airflow and can act as a barrier or cause airflow to exit across the face of the hood. Keep the back bottom slot clear at all times as it serves as an exhaust port for fumes and heat generated near the surface.
- Minimize traffic near and around the hood. A person walking past the hood can create competing air currents. Other cross drafts should be eliminated, such as open doors or fans.
- Use extreme caution with ignition sources inside a fume hood. Ignition sources such as electrical connections and equipment, hot plates, controllers, and open flames will ignite flammable vapors or explosive particles from materials being used in the hood. All electrical equipment used inside a fume hood must be designed or certified as intrinsically safe, unless it can be absolutely established (and enforced) that flammable or explosive materials will not be used in a particular hood.
- Never put your head inside a hood while operations are in progress. The plane of the sash is the imaginary boundary that should not be crossed except to set up or dismantle equipment.
- Do not dismantle or modify the physical structure or exhaust system without approval from the Department of Environmental Health and Safety. Modifications can result in a decrease in airflow and could make the hood less protective.
- Do not use hoods for general chemical storage. Only chemicals that require ventilation while in storage may be stored in a hood specified for that purpose.
- Position gas phase or particle generating sources well within hood.

Maintenance

- Keep lab clean and uncluttered.
- Inspect and maintain laboratory equipment regularly.

LABORATORY- SPECIFIC STANDARD OPERATING PROCEDURES

When working with a chemical that is hazardous and the safety procedures are not adequately addressed in the standard laboratory procedures, it is the responsibility of the individual Principal Investigators to develop safe procedures for specific chemicals and processes. In the standard operating procedure, procedures for chemical leaks and spills must be included. The procedure must include emergency contacts, emergency telephone numbers and other relevant information to properly manage chemical leaks and spills. All personal protective equipment must also be identified in the standard operating procedures. The Principal Investigator must be familiar with the chemicals, reactions, handling, and the associated hazards. Each Principal Investigator must include Laboratory Specific Standard Operating Procedures in this section of the Plan. Appendix A provides guidelines for hazard evaluation that can be used by investigators. Additional assistance in developing specific, safe operating procedures can be arranged through the Chemical Hygiene Officer.

PARTICULARLY HAZARDOUS SUBSTANCES

Specific standard operating procedures are required for use of substances that are classified as particularly hazardous. These substances are select carcinogens, reproductive toxins, and substances that display a high degree of acute toxicity. The standard operating procedures must include:

- Establishment of a designated area for use;
- Use of containment devices such as laboratory fume hoods or glove boxes;
- Acceptable plans for safe removal of waste; and
- Establishment of procedures for decontamination of material, area, and workers that contact the substance.

Procedures with particularly hazardous substances where the above requirements may be inappropriate or unwarranted due to small concentrations used, small quantities of substances handled, chemical states, or physical properties, the Principal Investigator may request a hazard assessment to be conducted by the Chemical Hygiene Officer. The Chemical Hygiene Officer will assess the chemical operations to determine if there is a potential risk of significant exposure that would result in an adverse health effect.

The Principal Investigator will be required to write specific standard operating procedures when the results of the hazard assessment identifies a risk of significant exposure.

For procedures where a risk of significant exposure does not occur based on the results of the hazard assessment, specific operating procedures are not required to be developed. The hazard assessment must be kept in the laboratory's Laboratory Safety/Chemical Hygiene Plan.

Additional care is required for any use of substances that are particularly hazardous. Substances of this type include select carcinogens, reproductive toxins, or substances that display a high degree of acute toxicity. Possible carcinogencity and the source of the data (e.g. OSHA, National Toxicology Program, International Agency for Research on Cancer) should be noted on the MSDS.

Prior approval is required before beginning work using particularly hazardous substances. Approval must be obtained from the Principal Investigator.

Select Carcinogens

A select carcinogen is any substance, which meets one of the following criteria:

- It is regulated by the Occupational Safety and Health Administration (OSHA) as a carcinogen; or
- It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC) (latest edition); or
- It is listed in either Group 2A or 2B by IARC; or
- It is listed under the category "reasonably anticipated to be carcinogens" by NTP.

Table X lists some substances that meet the above criteria and are classified as Particularly Hazardous Substances. The list is not all-inclusive.

Table X – Examples of Select Carcinogens

Acetaldehyde
2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Aflatoxins
4-Aminobiphenyl
Arsenic & certain arsenic compounds
Azathioprine
Barium chromate
Benzene
Benzidine
Bis(chloromethyl)ether
1,4-Butanediol dimethylsulfonate (myleran)
Carbon tetrachloride
Chlorambucil
Chloroform
Chloromethyl methyl ether
Chromium & certain chromium compounds
Cyclophosphamide
1,2-Dibromo-3-chloropropane
3,3'-Dichlorobenzidine (and its salts)
Diethylstilbestrol
4-Dimethylaminoazobenzene
Dimethyl sulfate
1,4-Dioxane
Ethyl carbamate (urethane)
Ethylene dibromide
Ethylene oxide
Ethylenimine
Formaldehyde
Hexamethylphosphoramide
Hydrazine
Melphalan
4,4'-Methylene-bis[2-chloroaniline]
α-Naphthylamine
β-Naphthylamine
Nickel carbonyl
4-Nitrobiphenyl
N-Nitrosodimethylamine
β-Propiolactone
Styrene
Thioacetamide
Thorium dioxide
Treosulfan
Vinyl chloride

Reproductive Toxins

Substances that affect the reproductive capabilities including chromosomal damage (mutations) and fetal effects (teratogenesis) are classified as Particularly Hazardous Substances.

Table X list some substances that are classified as reproductive toxins.

Table X – Examples of Reproductive Toxins

Arsenic & certain arsenic compounds	Ethylene oxide
Benzene	Lead compounds
Cadmium & certain cadmium compounds	Mercury compounds
Carbon disulfide	**Toluene**
Ethidium bromide	Vinyl chloride
Ethylene glycol monomethyl & ethyl ethers	**Xylene**

Substances that display a high degree of acute toxicity

Substances that display a high degree of acute toxicity have the ability to cause a harmful biological effect after a single or short exposure. Any compound that meets the criteria of "highly toxic" in Table X meets the criteria for handling as a Particularly Hazardous Substance.

Table X - Acute Toxicity Hazard Level

Toxicity Rating	Oral LD_{50} (Rats, per kg)	Skin Contact LD_{50} (Rabbits, per kg)	Inhalation LC_{50} (Rats, ppm for 1 h)	Inhalation LC_{50} (Rats, mg/m^3 for 1 h)
Highly Toxic	<50 mg	<200 mg	<200	<2,000
Toxic	50 to 500 mg	200 mg to 1 g	200 to 2,000	2,000 to 20,000
Slightly Toxic	500 mg to 5 g	1 to 5 g	2,000 to 20,000	20,000 to 200,000

Any chemical that has a NFPA Health Hazard Rating of 3 or 4 is considered a substance that displays a high degree of acute toxicity.

Table X list some substances that are classified as substances that display a high degree of acute toxicity.

Acrolein	Nickel carbonly
Arsine	Nitrogen dioxide
Chlorine	Osmium tetroxide
Diazomethane	Ozone
Diborane	Phosgene
Hydrogen cyanide	Sodium azide
Hydrogen fluoride	Sodium cyanide
Methly fluorosulfonate	

Substances with Unknown Hazards

When a chemical with an unknown hazard is brought into or produced in the laboratory, the Principal Investigator must handle that chemical as a Particularly Hazardous Substance as defined by the Plan. The Principal Investigator must demonstrate that the chemical does not meet the definition of a Particularly Hazardous Substance.

MONITORING, MEDICAL, AND CONTROL

Employee Exposure Monitoring

If there is a reason to believe that an employee's exposure to hazardous substances is routinely elevated to a level greater than one-half of generally acceptable exposure levels (OSHA Permissible Exposure Limits, ACGIH Threshold Limit Values, etc.) the Chemical Hygiene Officer will determine the employee's exposure. If the monitoring reveals that elevated exposures exist, then periodic exposure monitoring will be implemented according to the appropriate standards and corrective measures will be taken. Employees will be notified of the results of exposure monitoring within 15 days of the receipt of the results.

In the case of Particularly Hazardous Substances (based on carcinogenicity, reproductive toxicity, or acute toxicity at low levels) more care should be taken. Exposure monitoring should be conducted if there is a chance that an employee's exposure could ever exceed one-half of the acceptable exposure levels.

Contact the Chemical Hygiene Officer, Department of Environmental Health and Safety to arrange for monitoring or assistance in determining if monitoring is needed.

Medical Consultation and Examination

Employees will be provided with the opportunity to receive medical attention if:

- an employee develops signs or symptoms associated with the hazardous chemicals in use (refer to the Material Safety Data Sheet for the chemical), or
- when monitoring indicates exposure levels routinely above one-half the acceptable level of a specific OSHA regulated substance for which there are medical surveillance requirements, or
- an event such as a spill, leak, explosion, etc., occurs resulting in a likely hazardous exposure to the employee.

Contact the Department of Environmental Health and Safety when medical consultation is sought.

Control Measures

If exposure monitoring or other means of determination suggest that there may be chemical exposures exceeding one-half the acceptable level, additional control measures will be taken. These additional control measures may include, but are not limited to, process modification, improved local exhaust and general ventilation, and selection and use of appropriate respiratory protection following BGSU's Respiratory Protection Program.

The use of control measures to reduce chemical hazards is a part of prudent practice in all laboratory settings. In choosing and implementing controls, the Chemical Hygiene Officer can assist with the selection and implementation of controls. Controls will be selected from a four-leveled hierarchy:

1. **Elimination of the potential hazard**. The first choice for control is elimination or reduction of the source of the hazard. Choose the least hazardous method and use only the amount of the chemical needed.

2. **Control of hazard at the source**. The second choice is to control the hazard at the source, which is achieved by using local exhaust ventilation such as laboratory hoods, flexible ducts, and glove boxes. This control prevents the chemical from entering the laboratory's air. Laboratory hoods will be inspected at a minimum of once a year to ensure proper operation. The Environmental Health and Safety Department will conduct the laboratory hood inspections.

   Laboratory hoods used for chemical operations must have an average face velocity of 80 to 120 feet per minute (fpm). Laboratory hoods will be marked with an arrow indicating the sash height where 100 fpm can be achieved. An average face velocity of less than 80 fpm may not be adequate to control all hazards. An average velocity of greater than 120 fpm has been shown to achieve no increase in control efficiency and may reduce efficiency because turbulence inside the hood results in leakage. Laboratory hoods that have face velocities below 80 fpm or above 120 fpm shall not be used for chemical operations and shall be identified as such.

   Work practices that help maintain air flow in the hood are encouraged.

3. **Control of the hazard between the source and the worker**. The third choice is to control the exposure between the source and the worker. General room ventilation may be able to dilute concentrations to an acceptable level, but this should not be the primary means of control. General ventilation should never be used to control particulate hazards or gas phase hazards of moderate to high toxicity.

4. **Control of the hazard at the worker**. The final choice in the control hierarchy is control at the worker. This should never be the primary means of control since if it fails, there is no chance for alternate control measures. Control at the worker can be accomplished by the correct use of appropriate personal protective equipment (i.e. respiratory protection, safety glasses, face shields, gloves, and protective clothing). The use of personal protective equipment shall conform to the appropriate standards.

   Appropriate eye protection will be worn at all times in laboratories. Appropriate gloves will be used whenever using particularly hazardous chemicals or chemicals with significant skin damaging or skin absorption potential.

   Required personal protective equipment for laboratories is identified in Appendix B, however, consult the chemical's MSDS first.

   The Chemical Hygiene Officer can assist in the selection of proper personal protective equipment and provide training on its use.

INSPECTIONS

Inspection of safety in the laboratories by the Principal Investigator or their designee must be a monthly occurrence. The Principal Investigator's designee must be a member of the Principal Investigator's research group. By addressing potential hazards early, solutions can be simple and accidents can be avoided. Each lab will maintain a file of monthly inspections, which should be inserted in this section of the Plan. An inspection form is included in this section. The Chemical Hygiene Officer will perform annual laboratory inspections, including fume hood performance evaluations.

Monthly Self Inspection Checklist

Academic Year: _____ Performed By: _____

Building: _____ Room Number: _____

Answer in the appropriate box for each month. Y = Yes, N = No, N/A = Not Applicable

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July
Is the Chemical Hygiene Plan present in the laboratory?												
Are the Material Safety Data Sheets for all chemicals used in the laboratory present or accessible to laboratory workers?												
Are emergency phone numbers prominently displayed in the laboratory?												
Is the laboratory's fire extinguisher present and maintained?												
Are the lab hoods used for chemical operations kept free of general chemical storage?												
Are lab hoods operational?												
Are general ventilation supply diffusers open and operational?												
Are all chemical containers clearly labeled?												
Has the plumbed safety shower been tested within last 12 months and currently operational?												
Has the plumbed eye wash station been tested within last 12 months and currently operational?												
Are sharps containers available and used?												
Are compressed gas cylinders secured?												
Are incompatible chemicals kept separate?												
Are chemicals stored off floor?												
Are chemical containers stored on low shelves?												
Is the laboratory equipment adequately guarded?												
Is all electrical equipment properly grounded?												
Are the hazardous waste containers labeled and properly stored?												

TRAINING

Employees must receive safety training upon initial assignment to the laboratory and whenever a new hazard is introduced to the lab. The Principal Investigator for the lab shall ensure that laboratory employees receive the training that is defined in the Plan. Refresher training may be performed annually at the discretion of the Principal Investigator. Training documentation must be completed and kept with the Principal Investigator's Chemical Hygiene Plan.

Training will include

i. Contents and availability of the OSHA Standard
ii. Location and availability of each lab's Plan
iii. Details of the Plan
iv. The physical and health hazards in the lab (Laboratory Specific Standard Operating Procedures)
v. Acceptable exposure levels to chemicals in the lab
vi. Methods and observation that may be used to detect hazardous chemicals
vii. Signs and symptoms associated with exposures to chemicals in the lab
viii. Location and availability of reference material on the hazards, safe handling, storage, and disposal of chemicals in the lab. This can primarily be accomplished by, but is not limited to Material Safety Data Sheets.
ix. Measures that employees can take to protect themselves

Training for items ii, iv, and vii must be conducted under the direction of the Principal Investigator. The Principal Investigator shall conduct or arrange training with the Chemical Hygiene Officer for the other items.

REVIEW

This Plan will be reviewed, evaluated, and updated annually by the Chemical Hygiene Officer. Comments and suggestions for improvement of the Plan will always be accepted and promptly considered for inclusion. A revised Plan will be distributed to all Principal Investigators who are responsible for similar review and modification of their specific operating procedures.

APPENDIX A

SPECIFIC PROCEDURE HAZARD ASSESSMENT GUIDELINES

These guidelines are intended to assist individuals responsible for developing safe standard operating procedures for laboratories. These are only guidelines and can not cover every potential circumstance. The responsible individuals must also rely on their own professional expertise. Additional guidance can be arranged through the Chemical Hygiene Officer, Environmental Health and Safety Department.

Material Safety Data Sheets

As part of the Hazard Communication Standard, OSHA requires that all chemicals within a department be accompanied by a MSDS. A MSDS is a written document describing the hazards associated with the chemical. It includes chemical and physical characteristics of the substance, fire and explosion hazard data, reactivity data, health hazard data, precautions for safe handling and use, and appropriate control measures. By implementing the safe handling precautions and control measures recommended by the manufacturer on the MSDS, risks from chemicals can be greatly reduced.

Determining Need for Additional Control Measures

As an additional decision-making tool, the following approach can be used to determine the need for extra control measures or the possible need for quantitative exposure assessment. This approach is part of "A Strategy for Occupational Exposure Assessment by the Exposure Assessment Strategies Committee of the American Industrial Hygiene Association".

Characterize the degree of exposure to a chemical	Rating
No exposure	0
Infrequent exposure at low concentrations	1
Frequent exposure at low concentrations	2
Infrequent exposure at high concentrations	2
Frequent exposure at high concentrations	3
Frequent exposure at very high concentrations	4
Characterize the health effect of the chemical	Rating
No known effects	0
Reversible effects of little concern	0
Reversible of some concern	1
Severe reversible effects of concern	2
Irreversible effects of concern	3
Life threatening or disabling illness or injury	4

If the sum of the exposure rating and health effect rating of a chemical is greater than 3, additional measures beyond those described on the MSDS should be implemented.

APPENDIX B

PERSONAL PROTECTIVE EQUIPMENT

Hazardous Material Handled in the Laboratory	Personal Protective Equipment Required and Recommended
Acids Small containers < 1 liter	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.
Large containers > 1 liter	Safety goggles, appropriate gloves, closed toe shoes, and a rubber apron required. If a potential for a splash is high, it is advised to use both a face shield and goggles.
Caustic Liquids Small containers < l liter	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.
Large containers > 1 liter	Safety goggles, appropriate gloves, closed toe shoes, and a rubber apron required. If a potential for a splash is high, it is advised to use both face shield and goggles.
Flammable liquids	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.
Dispensing from 5 gal containers	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended. If the potential for a splash is high, it is advisable to use a face shield in addition to goggles.
Highly reactive liquid chemicals and high energy oxidizers	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended. Face shield or body shield must be used in addition to protective eyewear during the reaction based on the scale of the reaction.
Liquids with high acute toxicity (poisons)	Safety goggles, appropriate gloves, appropriate impermeable apron, closed toe shoes. Long sleeve lab coat recommended. If the potential for a splash is high, use impermeable coveralls and a face shield in addition to goggles.
Liquids with high chronic toxicity (carcinogens and reproductive toxins)	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.
Other hazardous liquid chemicals (not included in the above categories)	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.

Hazardous Material Handled in the Laboratory	Personal Protective Equipment Required and Recommended
Caustic solids (lime, etc.)	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeved lab coat recommended. If the potential of getting a chemical into the face is high, use a face shield in addition to goggles.
Flammable solids (alkali metals, red phosphorous, etc.)	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeved lab coat recommended.
Highly reactive solids & high energy oxidizers	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeved lab coat recommended. Face shield or body shield should be worn during reactions, based on the scale of the reaction, in addition to protective eyewear.
Solids of high acute toxicity (poisons)	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeve lab coat recommended. If work is done on an open bench and the potential for disseminating powder is high, appropriate respiratory protection must be used.
Solids of high chronic toxicity (carcinogens and reproductive toxins)	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeved lab coat recommended. If work is done on an open bench and the potential for disseminating powder is high, appropriate respiratory protection must be used.
Other hazardous solid chemicals (not included in the above categories)	Safety glasses, appropriate gloves, closed toe shoes required. Safety goggles acceptable. Long sleeved lab coat recommended.
Compressed toxic gases	Safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coats recommended.
Work with pressurized glass/plastic vessels (potential for creating flying fragments)	Face shield, safety goggles, appropriate gloves, closed toe shoes required. Long sleeved lab coat recommended.

Hazardous Material Handled in the Laboratory	Personal Protective Equipment Required and Recommended
Light Radiation	
Class IIIb Lasers	Protective eyewear of the appropriate optical density.
Class IV Lasers	Protective eyewear of the appropriate optical density.
Sources of UV light	Appropriate protective eyewear and appropriate gloves required. Long sleeved lab coat recommended. Based on the duration of exposure and the source, it is advisable to use a face shield instead of glasses.
Temperature extremes	
Heat (hot surfaces, hot solutions, etc.)	Face shield, appropriate thermal gloves, closed toe shoes required. Long sleeved lab coat recommended.
Cold (cold rooms)	Appropriate thermal gloves, closed toe shoes required. Long sleeved lab coat recommended.
Cryogenic gases (N_2, He_2, etc.)	Face shield, appropriate thermal gloves, closed toe shoe required. Long sleeved lab coat recommended.
Autoclave operation	Face shield, rubber apron, appropriate thermal gloves, closed toe shoes required. Long sleeved lab coat recommended.

APPENDIX C

OSHA STANDARD 29 CFR 1910.1450

OCCUPATIONAL EXPOSURE TO CHEMICAL HAZARDS IN LABORATORIES

1910.1450(a)
Scope and application.

1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.**1910.1450(b)**

Definitions --

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see select carcinogen).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) **Aerosol, flammable** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) **Gas, flammable** means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) **Liquid, flammable** means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) **Solid, flammable** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1910.1450(c)
Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)
Employee exposure determination –

> **1910.1450(d)(1)**
> Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).
>
> **1910.1450(d)(2)**
> Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.
>
> **1910.1450(d)(3)**
> Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.
>
> **1910.1450(d)(4)**
> Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)
Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)
Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)
Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)
Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)
The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)
The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)
Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)
Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910.1450(e)(3)(iii)
A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

1910.1450(e)(3)(iv)
Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910.1450(e)(3)(v)
The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910.1450(e)(3)(vi)
Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910.1450(e)(3)(vii)
Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

1910.1450(e)(3)(viii)
Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)
Establishment of a designated area;

1910.1450(e)(3)(viii)(B)
Use of containment devices such as fume hoods or glove boxes;

1910.1450(e)(3)(viii)(C)
Procedures for safe removal of contaminated waste; and

1910.1450(e)(3)(viii)(D)
Decontamination procedures.

1910.1450(e)(4)
The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910.1450(f)
Employee information and training.

1910.1450(f)(1)
The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

1910.1450(f)(2)
Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

1910.1450(f)(3)
Information. Employees shall be informed of:

1910.1450(f)(3)(i)
The contents of this standard and its appendices which shall be made available to employees;

1910.1450(f)(3)(ii)
the location and availability of the employer's Chemical Hygiene Plan;

1910.1450(f)(3)(iii)
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

1910.1450(f)(3)(iv)
Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

1910.1450(f)(3)(v)
The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

1910.1450(f)(4)
Training.

1910.1450(f)(4)(i)
Employee training shall include:

1910.1450(f)(4)(i)(A)
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1450(f)(4)(i)(B)
The physical and health hazards of chemicals in the work area; and

1910.1450(f)(4)(i)(C)
The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

1910.1450(f)(4)(ii)
The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

1910.1450(g)
Medical consultation and medical examinations.

1910.1450(g)(1)
The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910.1450(g)(1)(i)
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii)
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910.1450(g)(1)(iii)
Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

1910.1450(g)(2)
All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910.1450(g)(3)
Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i)
The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910.1450(g)(3)(ii)
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)
A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910.1450(g)(4)
Physician's written opinion.

1910.1450(g)(4)(i)
For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A)
Any recommendation for further medical follow-up;

1910.1450(g)(4)(i)(B)
The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C)
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D)
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii)
The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910.1450(h)
Hazard identification.

1910.1450(h)(1)
With respect to labels and material safety data sheets:

1910.1450(h)(1)(i)
Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii)
Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2)
The following provisions shall apply to chemical substances developed in the laboratory:

1910.1450(h)(2)(i)
If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii)
If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii)
If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910.1450(i)
Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)
Recordkeeping.

1910.1450(j)(1)
The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2)
The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k)
[Reserved]

1910.1450(l)
Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.
[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996; 71 FR 16674, April 3, 2006]

APPENDIX D

MATERIAL SAFETY DATA SHEETS (MSDSs)

Principal Investigators may place Material Safety Data Sheets in this section for future reference and training on chemicals that are specific to their laboratories.

APPENDIX E

This section contains acceptable chemical storage methods to segregate incompatible materials. The specific documents included are:

- Chemical Storage Guidelines
- Flinn Scientific Suggested Chemical Storage Pattern
- Fisher Scientific Suggested Storage Pattern

Chemical Storage Guidlines

General Guidelines

- Store dry chemicals on shelves.
- Store flammables together. Use approved flammable storage cabinets. If possible, they should be ventilated.
- Store acids and bases separately in chemical resistant cabinets. In labs with less space, acides and bases can be stored in the same cabinet but separated by plastic trays.

  Exception: Nitric acid, when combined with acetic acid on a tile/concrete floor, may create a fire. Therefore Nitric acid shall not be stored with acetic acid.
- Oxidizers and toxic substances should be stored near a hood.
- Store general cleaning materials under the sink.

Figure 20: Sample Storage Cabinets

Flammable Liquid Storage

The presence of flammable liquids in the laboratory presents a significant potential for fires and explosions in the laboratory. To minimize the potential for fires and explosions, flammable liquids must be stored as follows:

- No more then 38 liters of flammable liquid can be stored outside of a flammable liquid cabinet. This is equivalent to about nine 4-liter bottles stored in the laboratory outside of a flammable cabinet.

- Flammable storage cabinets do not need to be ventilated for fire protection. However, they can be ventilated to control odors.

Refrigerated Flammable Liquid Storage

Using domestic refrigerators and freezers for storage of flammable material is prohibited. Flammable vapors can accumulate in domestic refrigerators and freezers. When flammable vapor accumulates to a specific level and a source of ignition is provided (a thermostat, light switch, etc.), a fire or explosion can result.

Flammable liquids may only be stored in refrigeration equipment that is *explosion proof, explosion safe, laboratory safe*, or designated for *flammable material storage*. These refrigeration units must be approved by Underwriters Laboratory as acceptable for storage of flammable liquids.

Flinn Scientific Suggested Chemical Storage Pattern

Storage of laboratory chemicals presents an ongoing safety hazard. There are many chemicals that are incompatible with each other. The common method of storing these products in alphabetical order sometimes results in incompatible neighbors. For example, storing strong oxidizing materials next to organic chemicals can present a hazard.

A possible solution is to separate chemicals into their organic and inorganic families and then to further divide the materials into related or compatible families. Below is a list of compatible families.

Inorganic

Metals, Hydrides
Acetates, Halides, Iodides, Sulfates, Sulfites, Thiosulfates, Phosphates, Halogens
Amides, Nitrates (except Ammonium Nitrate) Nitrites, Azides
Hydroxides, Oxides, Silicates, Carbonates, Carbon
Sulfides, Selenides, Phosphides
Chlorates, Bromates, Iodates, Chlorites, Hypochlorites, Perchlorates, Perchloric Acid, Peroxides, Hydrogen Peroxide
Arsenates, Cyanides, Cyanates
Borates, Chromates, Manganates, Permanganates
Acids (except Nitric Acid. Store Nitric Acid on an isolated shelf by itself)
Sulfur, Phosphorus, Arsenic, Phosphorus Pentoxide

Organic

Acids, Amino Acids, Anhydrides, Peracides
Alcohols, Glycols, Surgars, Aminies, Amides, Imines, Imides
Hygrocarbons, Esters, Aldehydes, Oils
Ethers, Ketones, Ketenes, Halogenated Hydrocarbons, Ethylene Oxide
Epoxy Compounds, Isocyanates
Peroxides, Hydroperoxides, Azides
Sulfides, Polysulfides, Sulfoxides, Nitriles
Phenols, Cresols
Dyes, Stains, Indicators

Note: Volatile materials (ethers, hydrocarbons, etc.) must be stored in an explosion-proof refrigerator. The thermostat switch or light switch in a standard refrigerator may spark and set off the volatile vapor inside and thus cause an explosion.

This list is not a complete list and is intended only to cover the materials possibly found in an average laboratory setting. This is not the only method of arranging these materials and is purely offered as a suggestion.

Fisher Scientific Suggested Storage Pattern

ChemAlert* Storage Codes

A color-coded bar on the label of every Fisher chemical provides an instant guide to storage. The storage code color is also denoted by its initial, and spelled out for additional clarification. The five storage colors and their descriptions are as follows:

RED (R) — **Flammable**. Store in area segregated for flammable reagents.

BLUE (B) — **Health Hazard**. Toxic if inhaled, ingested, or absorbed through Skin. Store in secure area.

YELLOW (Y) — **Reactive and Oxidizing Reagents**. May react violently with air, water, or other substances. Store away from flammable and combustible materials

WHITE (W) — **Corrosive**. May harm skin, eyes, mucous membranes. Store away from red-, yellow-, and blue-colored regents above.

GREY (G) — Presents no more than moderate hazard in any of categories above. For general chemical storage.

Exception. Denoted by the word "STOP." Reagents Incompatible with other reagents of the same color bar. Store separately.